What Offshore CCS Will Look Like in The Gulf of Mexico: Perspectives from Texas

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What Offshore CCS Will Look Like in The Gulf of Mexico
Perspectives from Texas

Tip Meckel, Ramon Trevino, and Susan Hovorka

Gulf Coast Carbon Center

TEXAS Geosciences
Bureau of Economic Geology
Jackson School of Geosciences
The University of Texas at Austin

Bureau of Economic Geology

TOPICS

- What is the maturity of CCS in the Gulf Coast region?
  - Many prior projects (research/demo, industrial)
  - Existing capture and pipeline transport infrastructure, upper coast
- Prior work to mature near offshore storage in the Miocene geology
  - Summary of prior geologic storage assessments since 2009
  - Atlas publication
- Examples of Miocene-age reservoir capacity estimates
  - San Luis Pass
  - High Island

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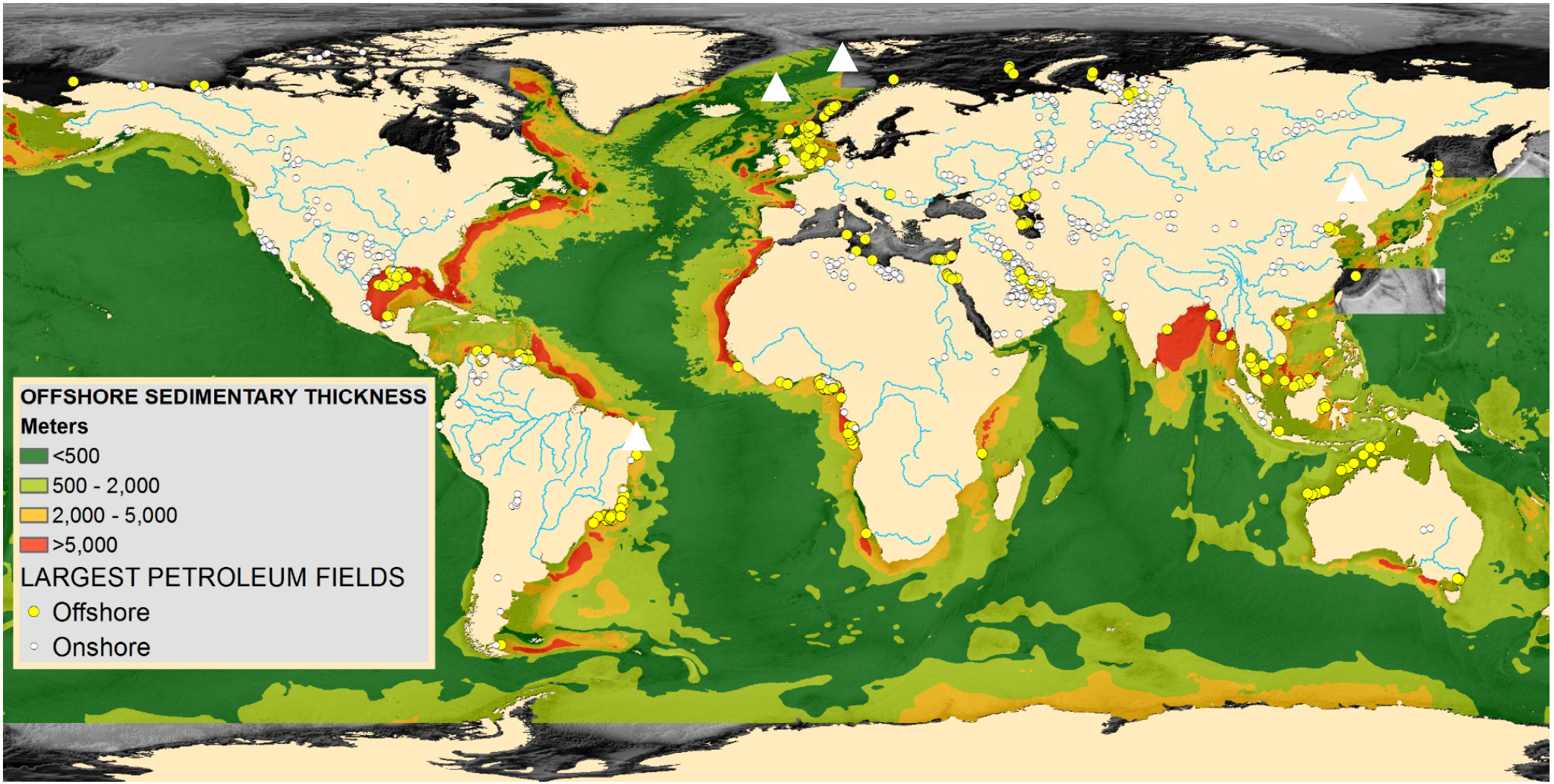
Offshore continental margins are the most promising for near-term Gigatonne-scale storage



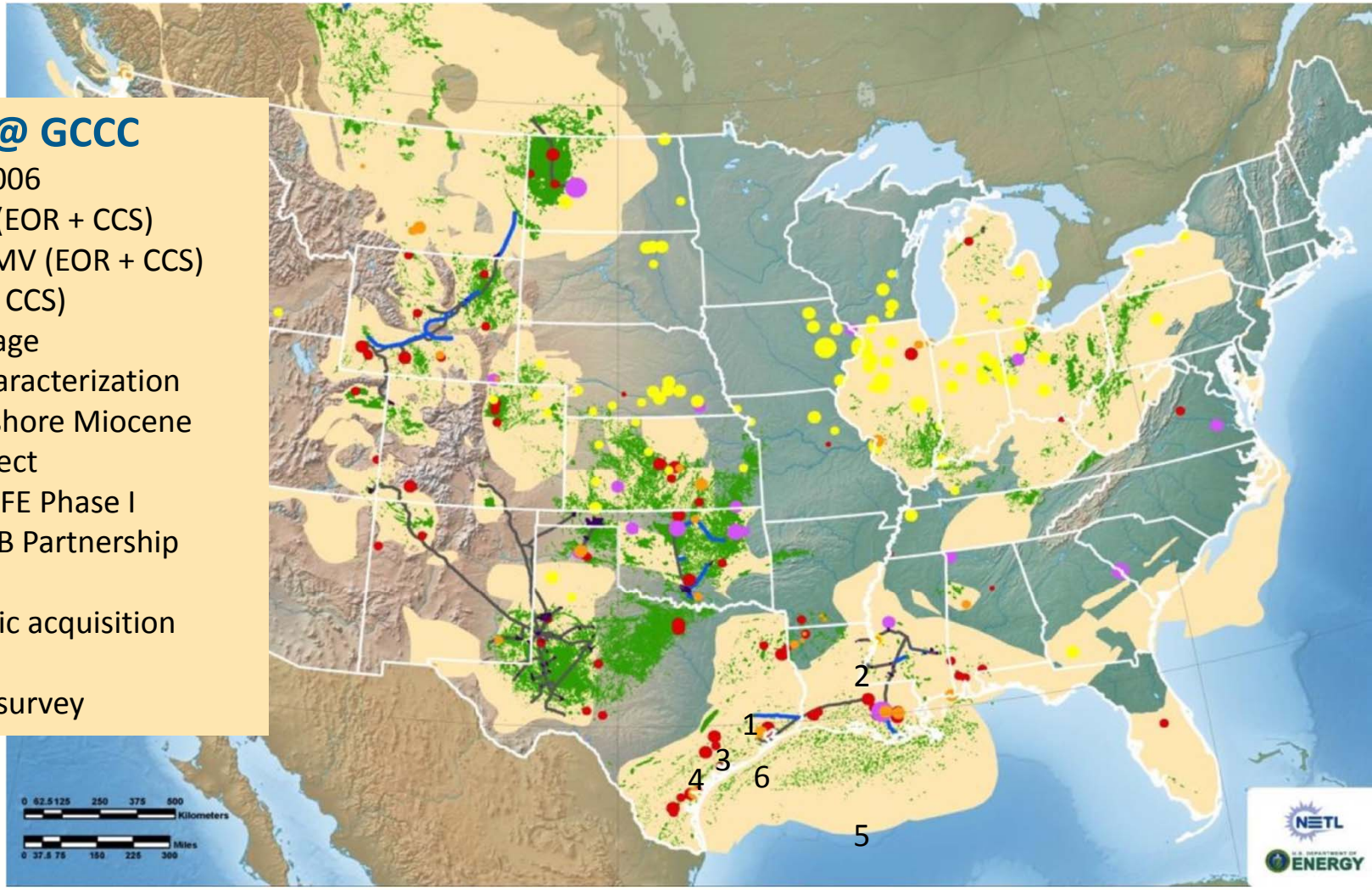
Regional Gulf Coast setting for rapid large-scale carbon management in U.S. heavy industry

Gulf Coast CCS @ GCCC

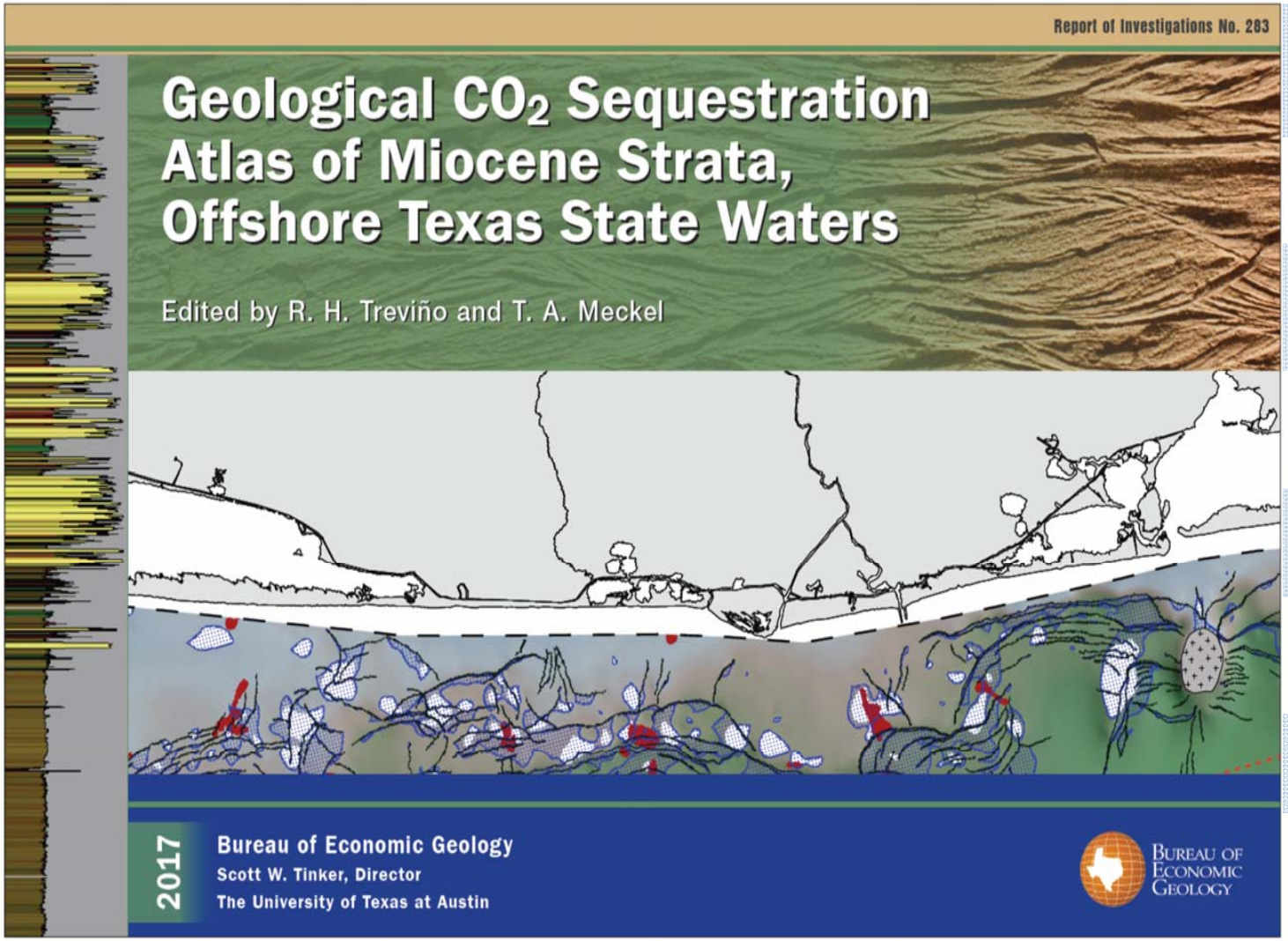
1) Frio Saline tests 2004 & 2006
2) Cranfield stacked storage (EOR + CCS)
3) Air Products - Hastings MMV (EOR + CCS)
4) NRG – West Ranch (EOR + CCS)
5) BOEM BPM Offshore Storage
6) Offshore GoM Storage Characterization
    1. 2009-2014 Texas Offshore Miocene
    2. 2015-2018 TXLA Project
    3. 2016-2018 CarbonSAFE Phase I
    4. 2018–2023 GoMCARB Partnership

High-resolution 3D seismic acquisition

- 3 GoM surveys
- 1 Tomakomai, Japan survey



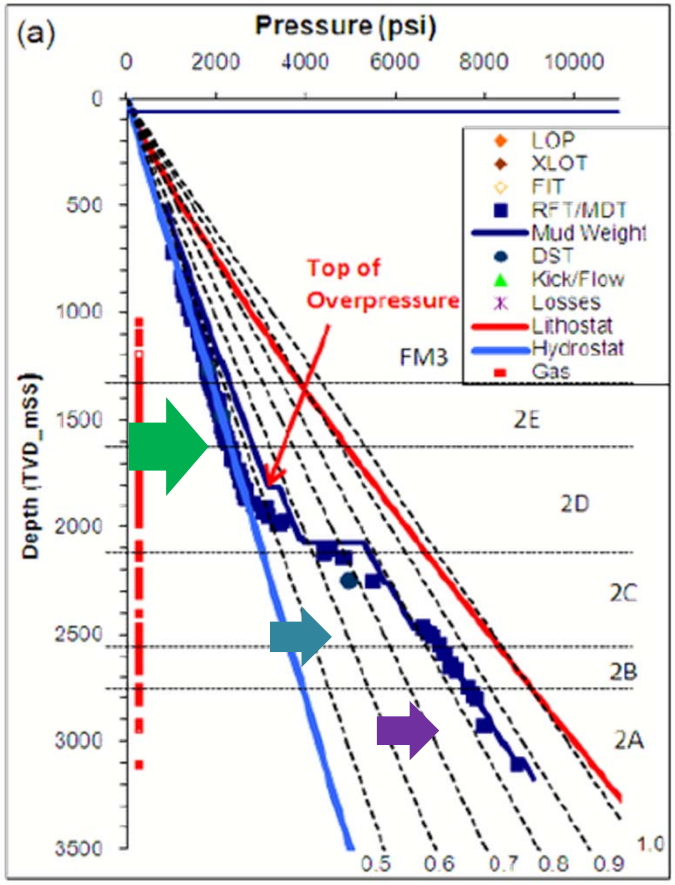
Prior Comprehensive Study of CO_2 Storage in State Waters



1. Regional Geology of the Gulf of Mexico and the Miocene Section of the Texas Near-offshore Waters
2. Implications of Miocene Petroleum Systems for Geologic CO_2 Storage beneath Texas Offshore Lands
3. Evaluation of Lower Miocene Confining Units for CO_2 Storage, Offshore Texas State Waters, Northern Gulf of Mexico, USA
4. Capillary Aspects of Fault-Seal Capacity for CO_2 Storage, Lower Miocene, Gulf of Mexico
5. Regional CO_2 Static Capacity Estimate, Offshore Saline Aquifers, Texas State Waters
6. Field-scale Example of Potential CO_2 Sequestration Site in Miocene Sandstone Reservoirs, Brazos Block 440-L Field
7. Estimating CO_2 Storage Capacity in Saline Aquifer Using 3D Flow Models, Lower Miocene, Texas Gulf of Mexico
8. Appendix A: Regional Cross Sections, Miocene Strata of Offshore Texas State Waters

Typical subsurface pressure profile

Overpressures in the Northern Malay Basin



Limpornpipat et al., 2011, DOI: 10.2523/IPTC-15350-MS

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CCS Resource Implications

Primary: Normal pressure (CENOZOIC)

Secondary: Elevated pressure (MESOZOIC)

Tertiary: High pressure, brine extraction?

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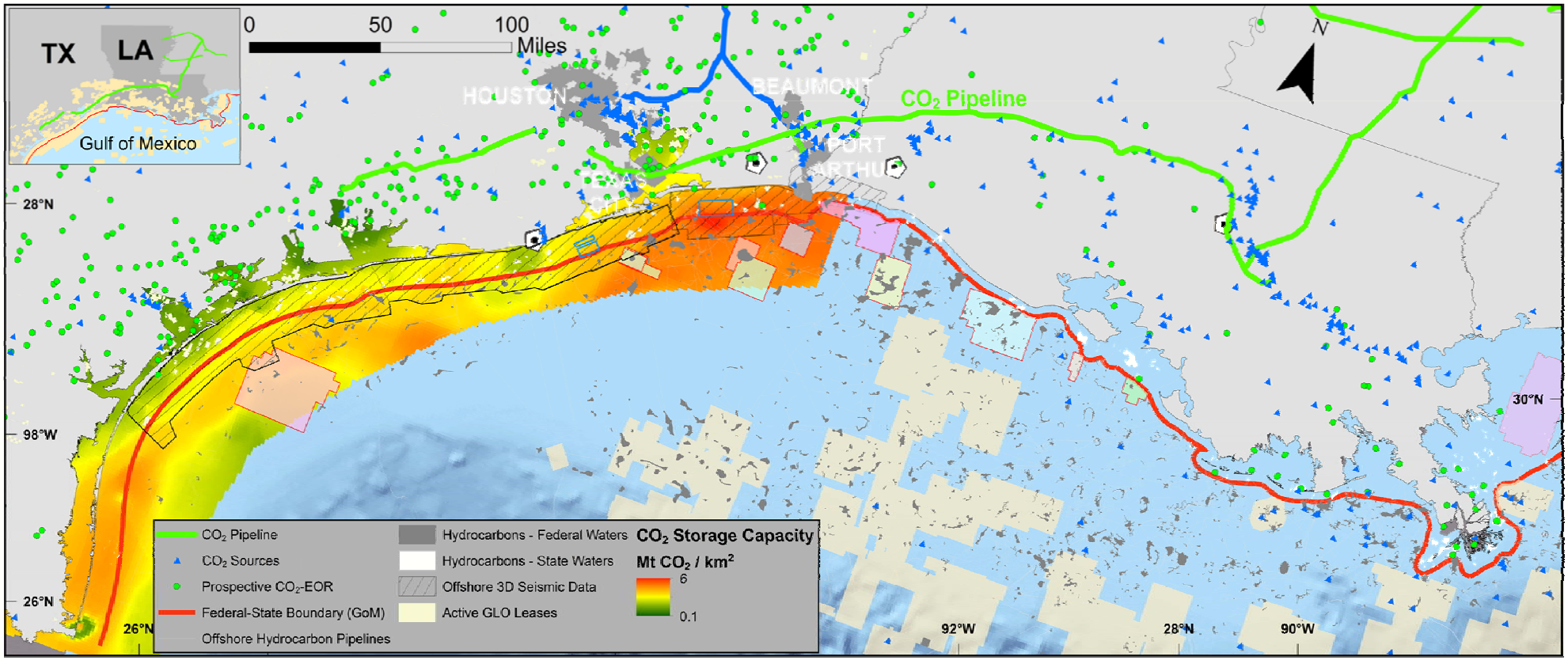
Static Regional Capacity

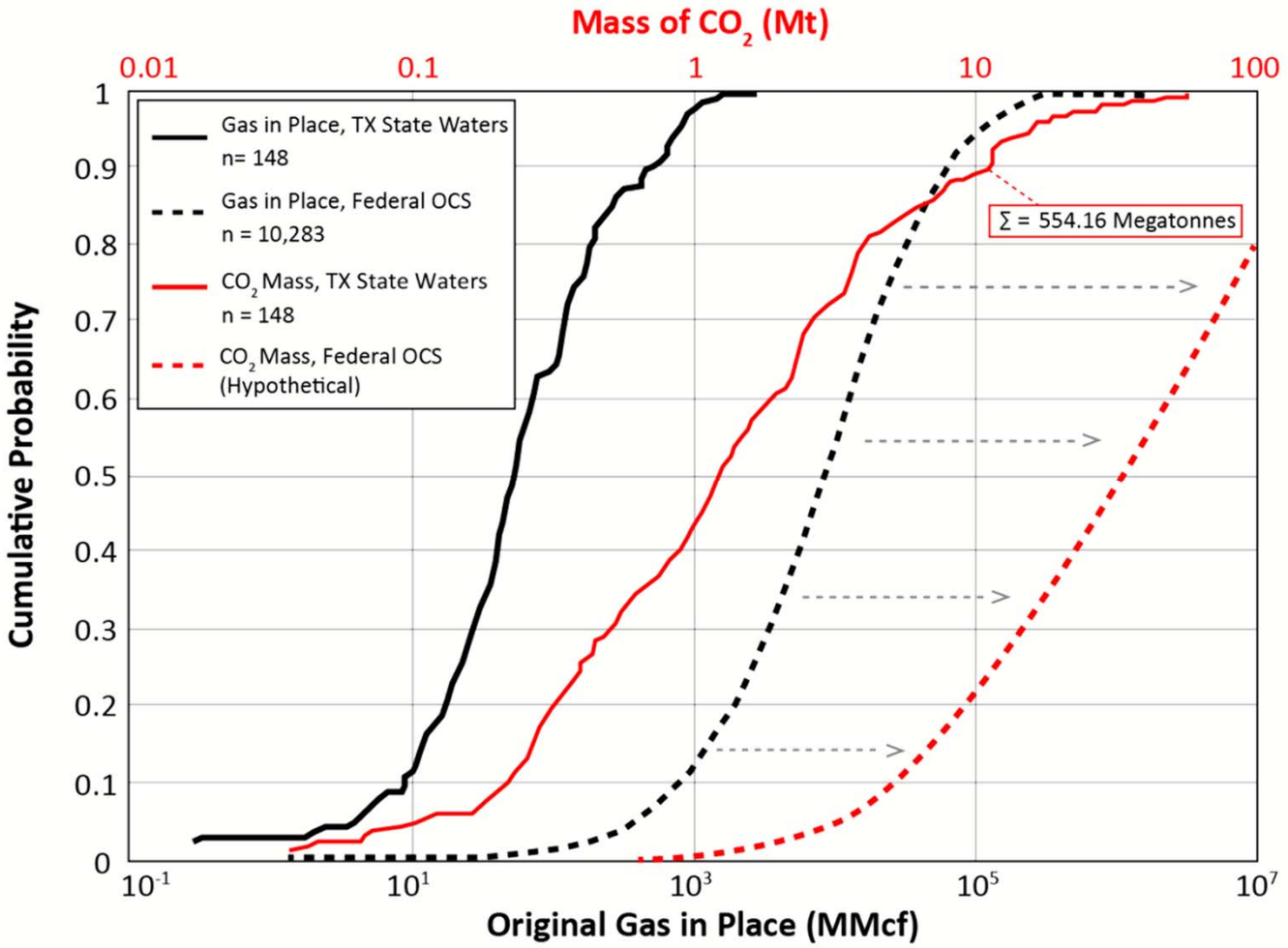
- NETL Methodology
- 40,000 sq. km.

- 3,300 logs
  - Tops, net sand, porosity

- 172 Gt CO_2 storage total TX State Waters



Converting methane gas experience to CO_2 storage



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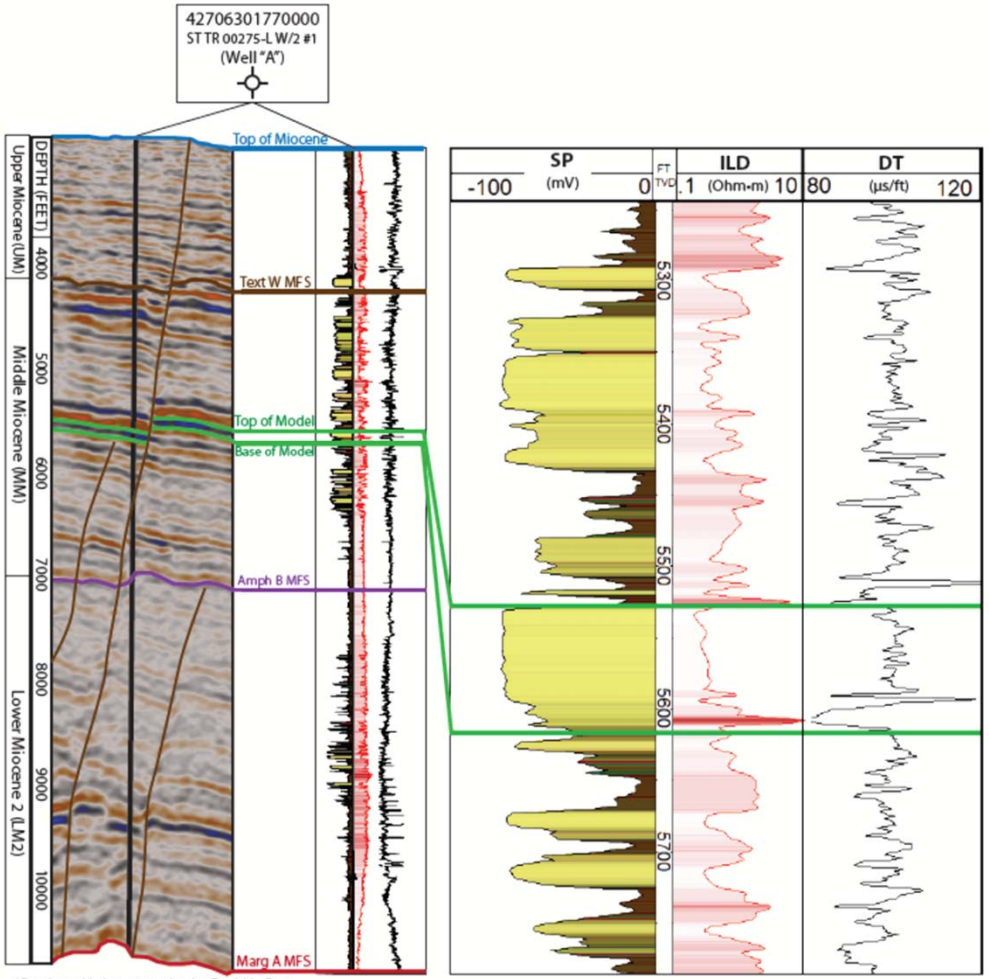
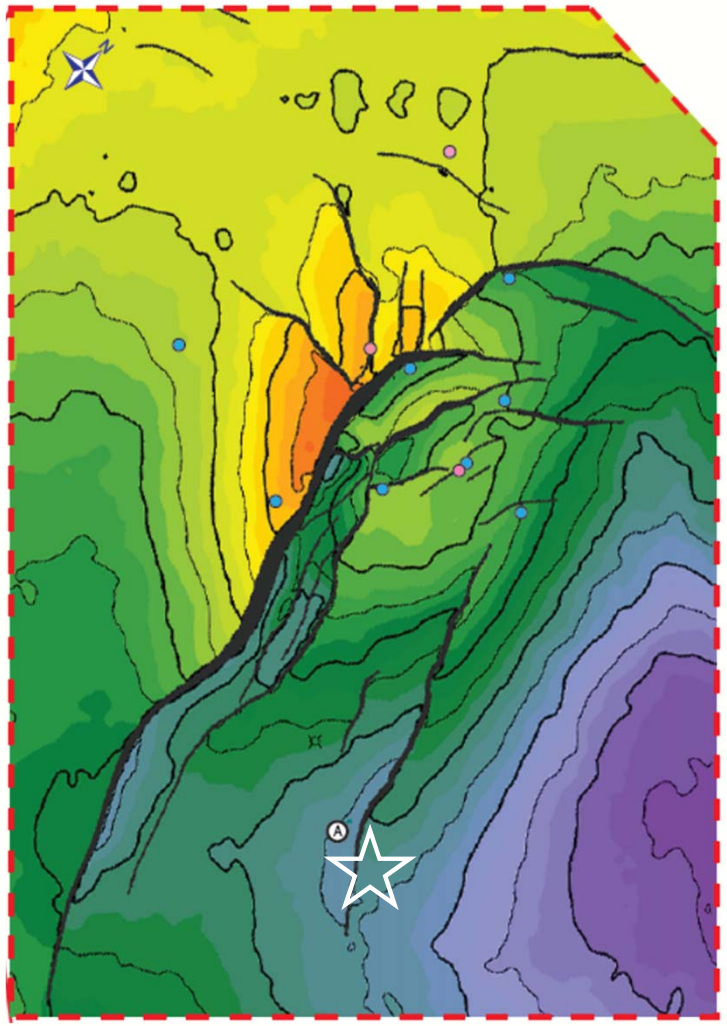
Reservoir Performance – Nonproductive Setting (San Luis Pass)



*Stratigraphic interpretation by David L. Carr
**Seismic data owned or controlled by Seismic Exchange, Inc.; interpretation is that of Kerstan Wallace



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Approximately 5 Mt in 90’ sand, unless completely open flow boundaries

Cumulative Injection Results for 27 dynamic 3D flow simulations

3D Flow Model Injected-Mass Results (Mt)			
	Homogeneous	Statistic-Based Heterogeneous	Seismically Derived Heterogeneous
Base case	5.4	5.3	4.5
High-quality reservoir	6.9	6.8	5.7
Low-quality reservoir	3.7	3.5	3.1
Open boundaries	*116.2*	*114.4*	*64.0*
Open faults	5.6	5.3	4.6
1 well	6.0	5.7	5.0
15 wells	5.4	5.2	4.8
Optimized array	5.4	5.3	4.9
Constant-rate injection	4.8	5.1	4.5

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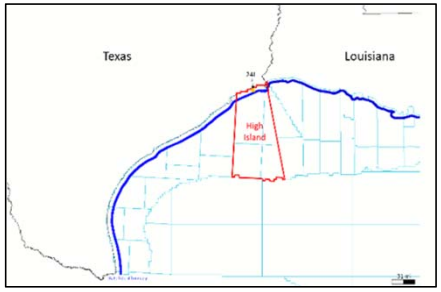
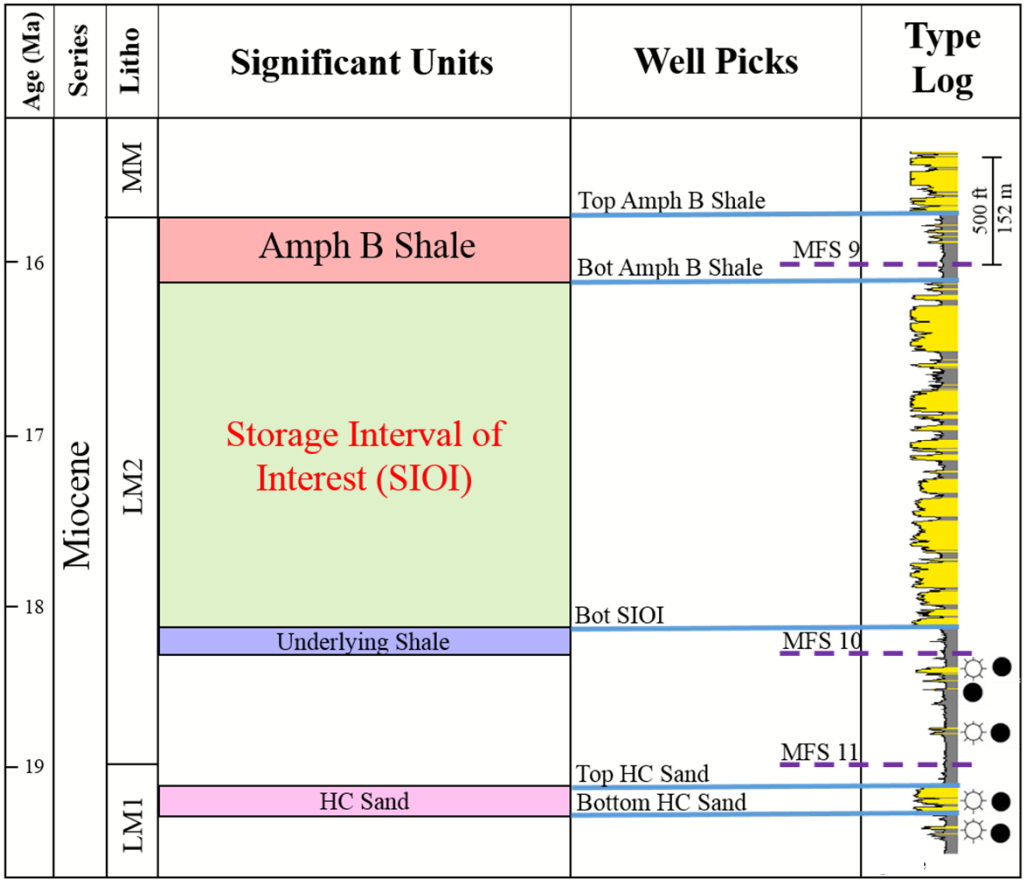
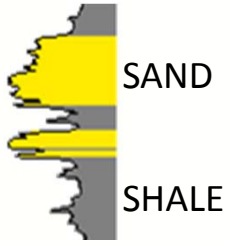
CCS Perspectives Benefit from Knowing Petroleum History



High Island 24-L Field
~10% of all oil and gas from Texas state waters





MFS 9-10 Interval

- 1720’ gross thickness
- 1066’ net sand
  - 62% net/gross
    - *Average from 37 SP curves*
- **No productive intervals**

Below MFS 10

~0.5 Tcf Gas

- 3625 ft total thick package
- 525 ft net sand (15%)
- 225 ft charged sand (43% of net sand)
- HC Sand most productive

MFS = Interpreted Maximum Flooding Surface Horizon (Galloway et al., 1989)

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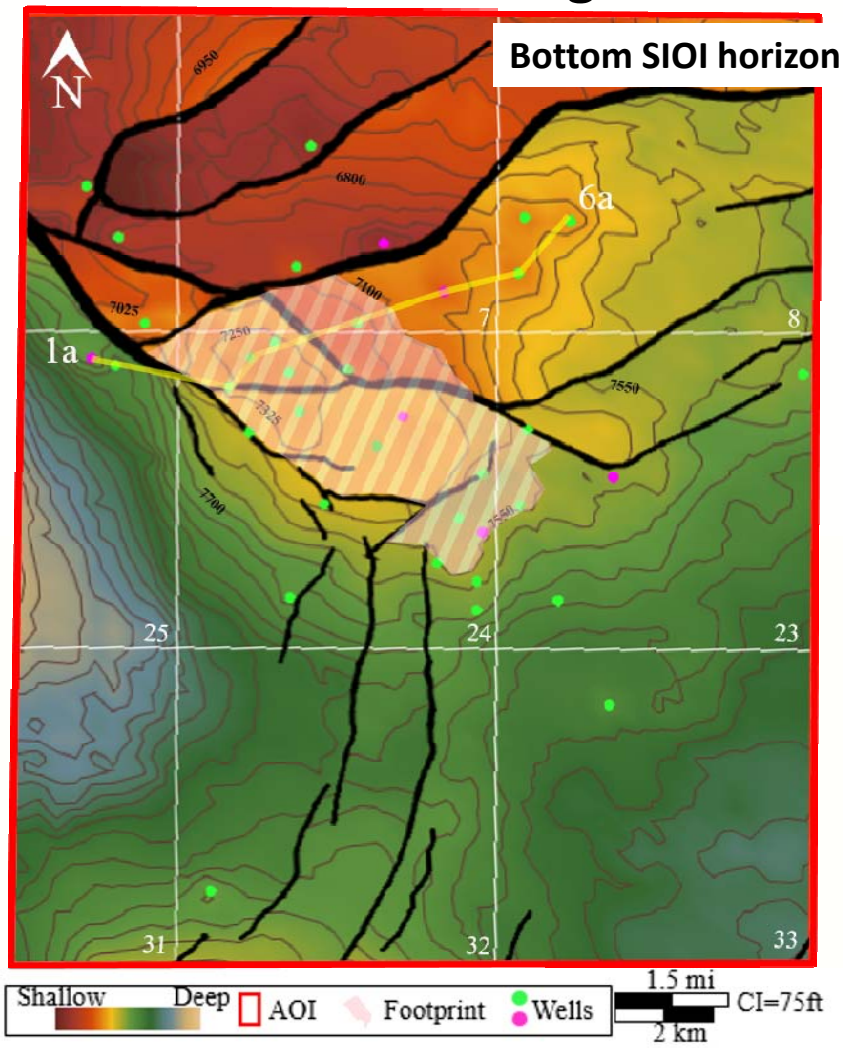
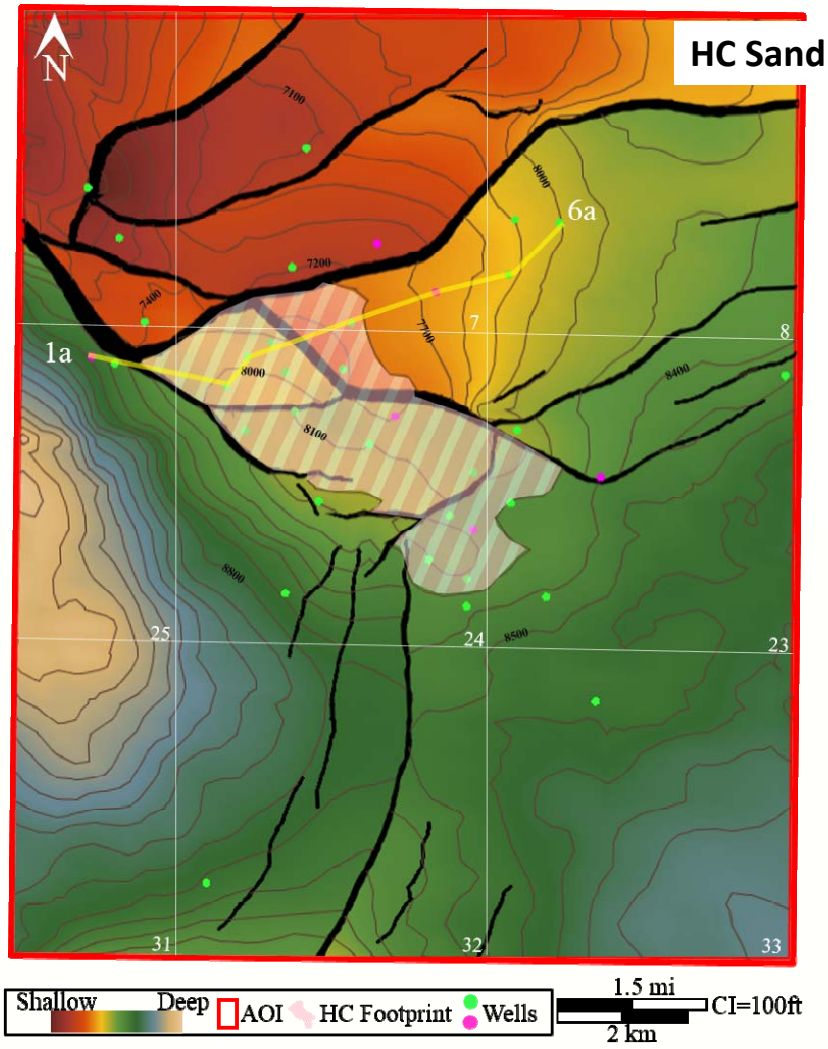
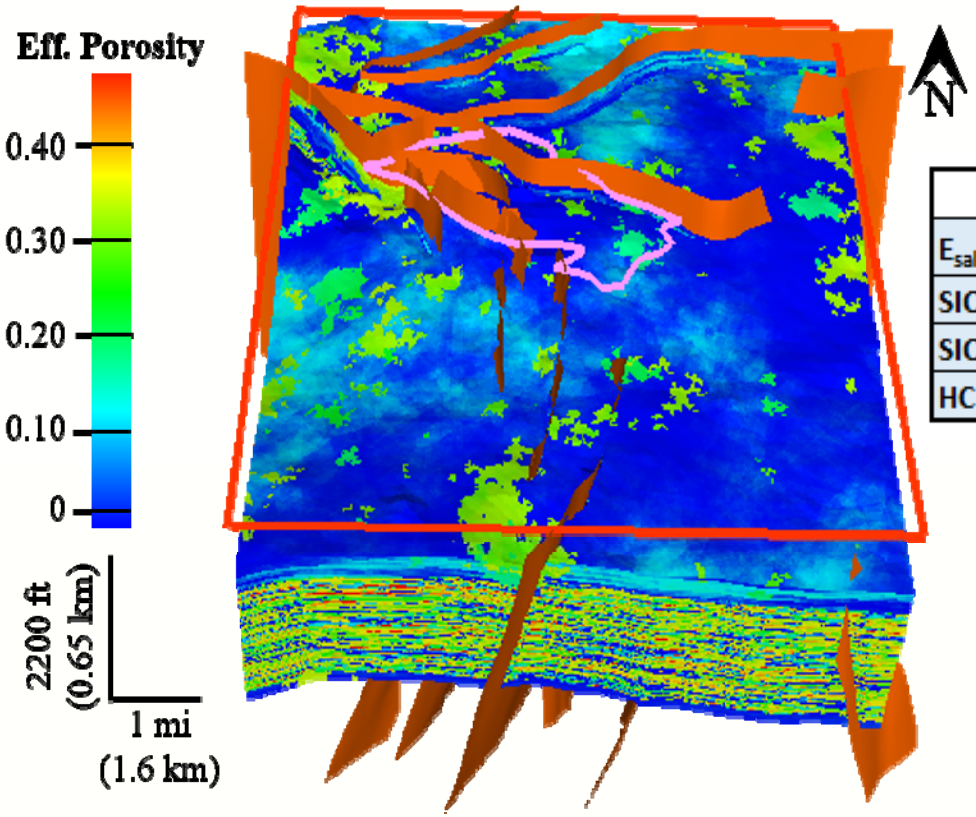
High Island 24-L Field – Southeast Texas





Approximately 12 Mt storage in 200’ sand, maybe 100 Mt in thickest intervals



	P10	P50	P90
$E_{saline} = E_v E_d$	7.4%	14%	24%
SIOI: NETL CO2 Screen (Mt)	63	120	206
SIOI: 3-D Eff. Porosity Model (Mt)	57	108	185
HC Sand: 3-D Constant Avg. Eff. Porosity Model (Mt)	6	12	20

Geo-cellular effective porosity model used for calculating CO_2 storage capacity in the SIOI. The AOI is outlined in red, SIOI structural footprint in pink, and faults are in orange.

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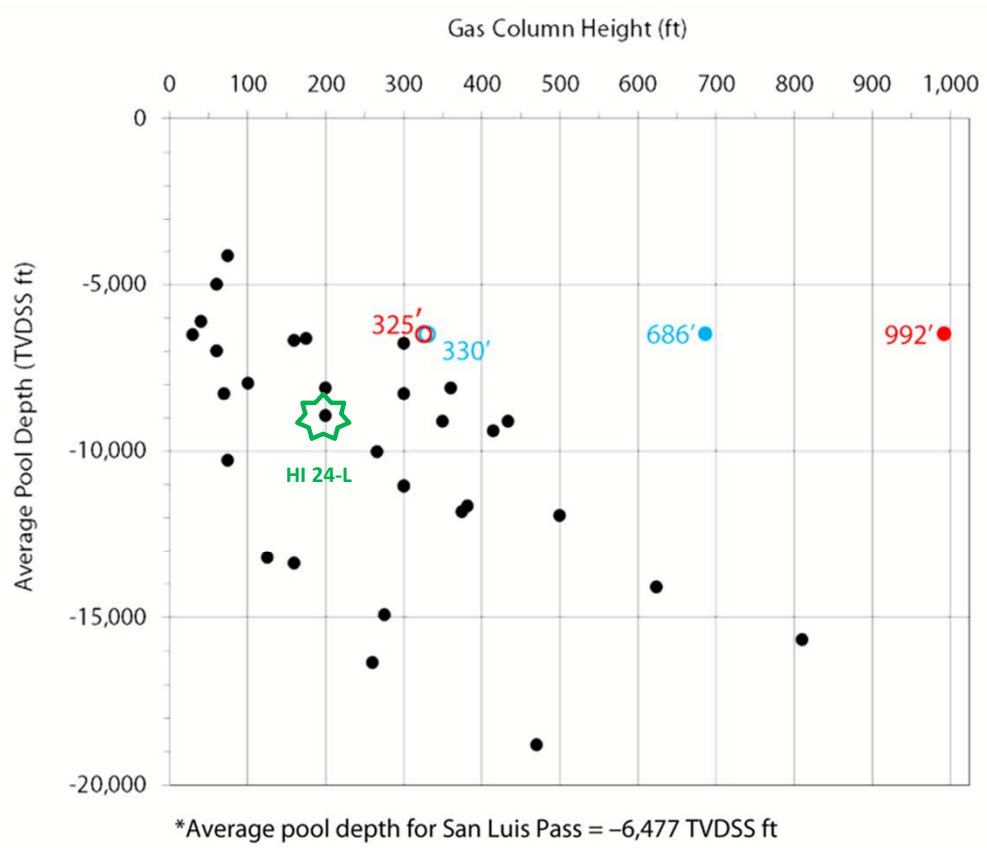
Caveat: Fault Seal Capacity

Estimated Gas Column Heights for the Fault A Structure vs. Regional Data from Seni *et al.*, 1997



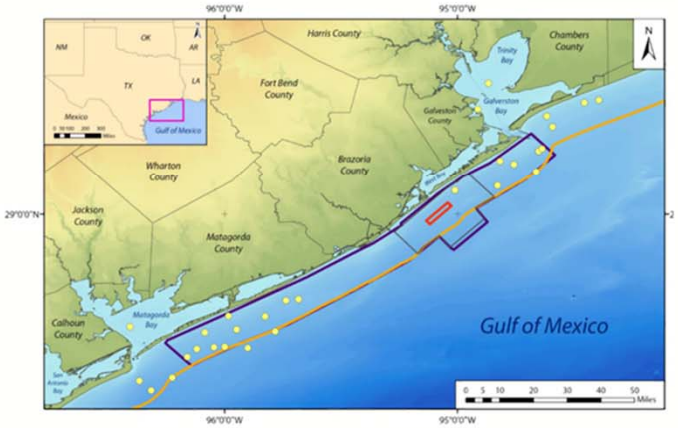
*Average pool depth for San Luis Pass = –6,477 TVDSS ft

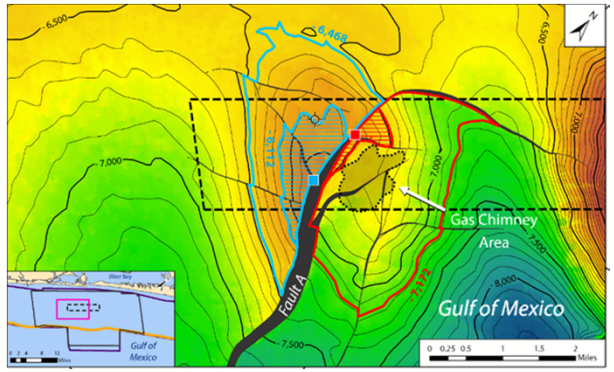
Key to Chart Symbols

- Seni et al., 1997
- Fill-to-Spill: FW
- Fill-to-Spill: HW
- Fault Seal Membrane: FW
- Fault Seal Membrane: HW

Key to Map Symbols

- Accumulation Data Locations from Seni *et al.*, 1997





J. Osmond MS Thesis
UT-Austin, 2016

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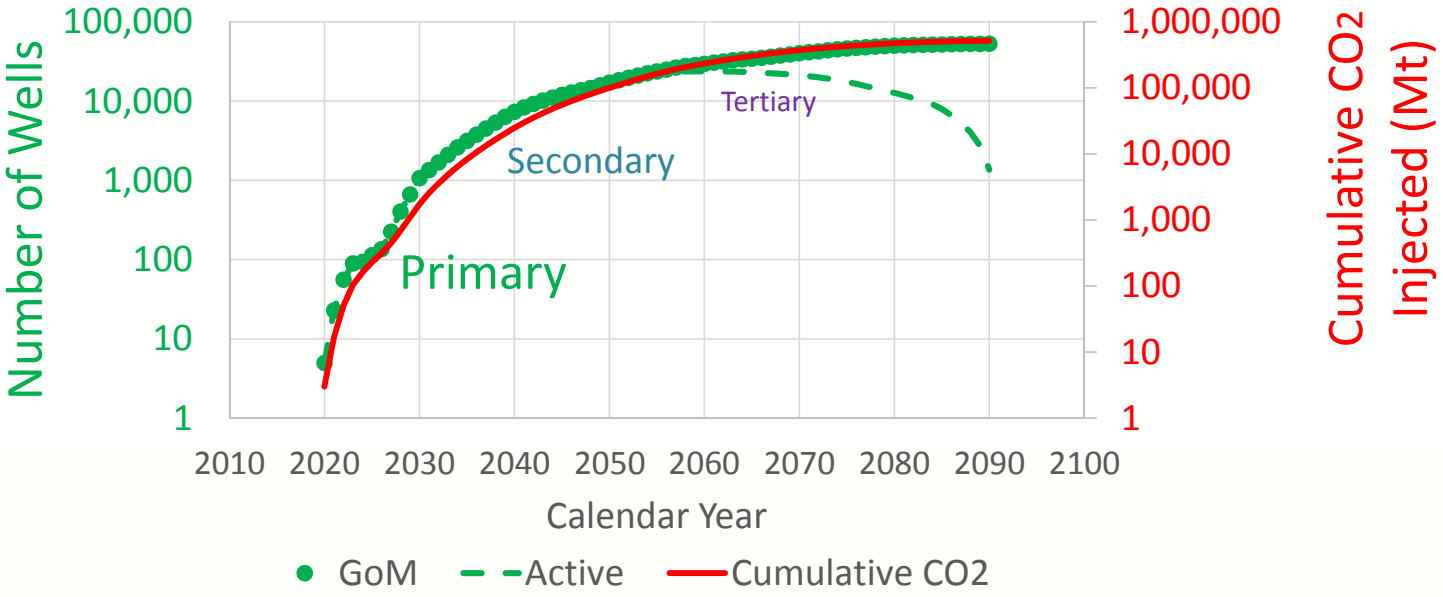
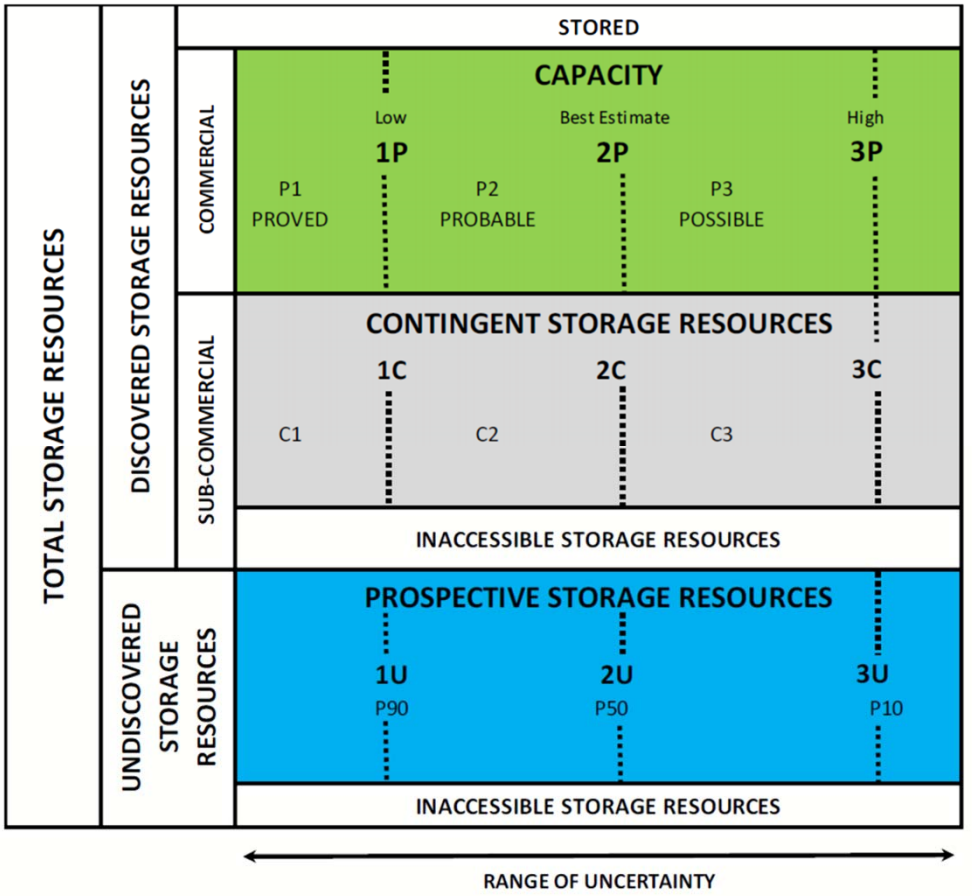
Gulf of Mexico – CO_2 well development scenario



2020+ SCENARIO	Avg. Well Inj. Rate Mt/yr	Number of active wells in 2050	Incremental Rate in 2050 Mt/yr	Cumulative Mass in 2050 Mt CO2	Comment
GoM	0.6	17,175	10,305	99,946	Unlikely one region will develop this aggressively; Incremental goal exceeded; Close to cumulative goal
GoM	0.41	17,175	7,000	67,891	Injection rate low, not cost effective; Cumulative goal not met

SPE Storage Resources Management System (SRMS)

- Bookable storage
- Uniformity, clarity, familiarity
- Similar to PRMS
  - SRMS exists
  - https://www.spe.org/industry/CO2-storage-resources-management-system.php
  - ***Guidelines currently being drafted***



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SUMMARY

- The global offshore continental margins represent the best near-term opportunity for Gigatonne-scale CCS.
  - Gulf of Mexico is ideal geologically.
  - Research need is to understand impact of Gt-scale pressure perturbation.

- We have all the geologic tools we need to be successful with large-scale CCS deployment.
  - CC(U)S perspectives benefit from knowing your petroleum history: capacity, seal, reservoir performance, well development.

- CCS can deliver needed scales on needed time frames.

- CO_2 storage can be a bookable resource for reassuring investors and evaluating project economics.

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An International Perspective

"Someone else may perceive this as a problem, but really it's not — it's an opportunity to create more jobs and wealth while implementing sustainability measures that address our emissions," David Alexander, petroleum researcher at The University of Trinidad and Tobago.

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An American O & G Industry Leader's Perspective

"We're not the ones creating the C02 but we are the ones uniquely qualified to deal with it."

John Gibson, former President and CEO of ***Tervita*** *and* ***Halliburton***

https://www.energysociety.org/the-transformation-of-the-og-sector.html

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Acknowledgements / Thank You / Questions

U.S. DEPARTMENT OF ENERGY
NETL

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